

Data Analyses in Connection with the  
NATIONAL GEODETIC SATELLITE PROGRAM  
Contract No. NSR 09-015-018

Quarterly Progress Report No. 13  
for the period April 1, 1968, through June 30, 1968

Principal Investigator: Dr. C. A. Lundquist  
Project Administrator: Mr. R. W. Martin

September 1968

Prepared for  
National Aeronautics and Space Administration  
Washington, D.C. 20546

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## Data Analysis

During this quarter, E. M. Gaposchkin concentrated on improving the gravity-field-determination computer program for the Standard Earth calculation to be performed later this year. It has been extended and improved and is now working well. Analytical extensions to the gravity-field-determination program include the capability for handling zonal harmonics up to degree 21 in place of 14 as in 1966, and more powerful air-drag and solar-radiation-pressure theories. Other improvements include more refined techniques for treating doppler data and refinements in generalized data-processing programs.

The bulk of the computational effort this quarter was devoted to orbit determinations for use by Dr. Y. Kozai in a new zonal-harmonics determination this summer. Fourteen of the 15 satellite-observation files to be analyzed have been completed with mean elements determined independently every 2 days. These files, consisting of some 123,000 Baker-Nunn observations covering intervals of up to 5 and 6 years, are displayed in Table 1. Note the variety of inclinations in the satellite orbits used. Kozai's determination should result in a superior representation of the zonal harmonics up to degree 21.

## Data Reduction

The analysis of simultaneous-observation data will begin next quarter when reduction of data for more than 500 observation pairs is complete. These data will allow four new Baker-Nunn stations to be included in the SAO

geometrical network. In addition, seven of the longer interstation lines will be considerably strengthened by the new data.

Table 2 shows the data to be analyzed, and Figure 1 illustrates the expansion and strengthening of the geometrical network.

#### International Participation

The 6-month program of cooperation with the French National Space Agency (CNES) in tracking six laser-reflecting satellites (including Geos 1 and Geos 2) was well under way at the end of this quarter. This program was discussed in Progress Report No. 12.

Observatories in Helsinki, Finland; Riga, Latvia; and Uzhgorod, USSR, have continued to report successful observations of Geos 2 flash sequences.

Table 1. Satellite observation files analyzed for zonal-harmonics determination.

|                                | Inclination | Start date | End date | Observations  |
|--------------------------------|-------------|------------|----------|---------------|
| 59 01A Vanguard 2              | 33°         | 12/24/59   | 7/28/66  | 15,790        |
| 60 09B Echo 1 Rocket           | 47          | 9/11/60    | 10/31/65 | 18,559        |
| 61 15A Transit 4A              | 67          | 8/8/61     | 12/5/64  | 3,227         |
| 61 15B Injun SR 3              | 67          | 8/5/61     | 1/20/64  | 2,497         |
| 61 28A Midas 4                 | 96          | 2/13/62    | 3/9/66   | 32,139        |
| 62 29A Telstar 1               | 45          | 7/23/62    | 8/27/64  | 5,192         |
| 62 60A Anna 1B                 | 50          | 10/31/62   | 5/8/66   | 8,979         |
| 62 68A Relay                   | 48          | 12/29/62   | 6/3/65   | 2,257         |
| 63 13A Telstar 2               | 43          | 5/11/63    | 6/30/64  | 2,130         |
| 63 26A Geophysical<br>Research | 50          | 6/30/63    | 9/11/65  | 3,158         |
| 63 53A Explorer 19             | 79          | 12/19/63   | 6/12/67  | 8,644         |
| 64 01A                         | 70          | 6/1/64     | 9/11/65  | 1,644         |
| 64 64A Explorer 22             | 80          | 10/11/64   | 6/3/67   | 1,420         |
| 65 81A OGO 2                   | 87          | 10/15/65   | 12/9/66  | 4,593         |
| 65 89A Geos 1                  | 59          | 11/8/65    | 3/25/67  | <u>13,282</u> |
|                                |             |            | Total    | 123,511       |

Table 2. Simultaneous observation data available for analysis.

| Station pair                                                 | Distance<br>(km) | No. of<br>pairs | Previously<br>available pairs |
|--------------------------------------------------------------|------------------|-----------------|-------------------------------|
| <u>New Stations(*)</u>                                       |                  |                 |                               |
| Comodoro Rivadavia, Argentina* - Peru                        | 3251             | 34              | -                             |
| Comodoro Rivadavia, Argentina* - Villa<br>Dolores, Argentina | 1561             | 33              | -                             |
| Comodoro Rivadavia, Argentina* - Brazil*                     | 5257             | 18              | -                             |
| Brazil* - Spain                                              | 5402             | 34              | -                             |
| Brazil* - Peru                                               | 4056             | 34              | -                             |
| Brazil* - Curaçao                                            | 4150             | 9               | -                             |
| Brazil* - Villa Dolores, Argentina                           | 4163             | 14              | -                             |
| Ethiopia* - South Africa                                     | 3945             | 37              | -                             |
| Ethiopia* - Spain                                            | 5324             | 34              | -                             |
| Ethiopia* - India                                            | 4687             | 24              | -                             |
| Ethiopia* - Iran                                             | 2692             | 39              | -                             |
| Ethiopia* - Greece*                                          | 3532             | 30              | -                             |
| Greece* - Spain                                              | 2632             | 23              | -                             |
| Greece* - Iran                                               | 2786             | 30              | -                             |
| <u>Long Ties</u>                                             |                  |                 |                               |
| New Mexico - Peru                                            | 6287             | 7               | 24                            |
| Spain - Curaçao                                              | 6465             | 7               | 35                            |
| Spain - Florida                                              | 6581             | 16              | 28                            |
| Japan - Hawaii                                               | 6142             | 7               | 19                            |
| Japan - Johnston Island                                      | 5275             | 3               | 18                            |
| Florida - Cold Lake, Canada                                  | 3859             | 15              | 46                            |
| Hawaii - Cold Lake, Canada                                   | 5238             | 11              | 19                            |
| <u>Others</u>                                                |                  |                 |                               |
| New Mexico - Rosamond, California                            | 1088             | 31              | -                             |
| Spain - Malvern, United Kingdom                              | 1768             | 27              | 17                            |

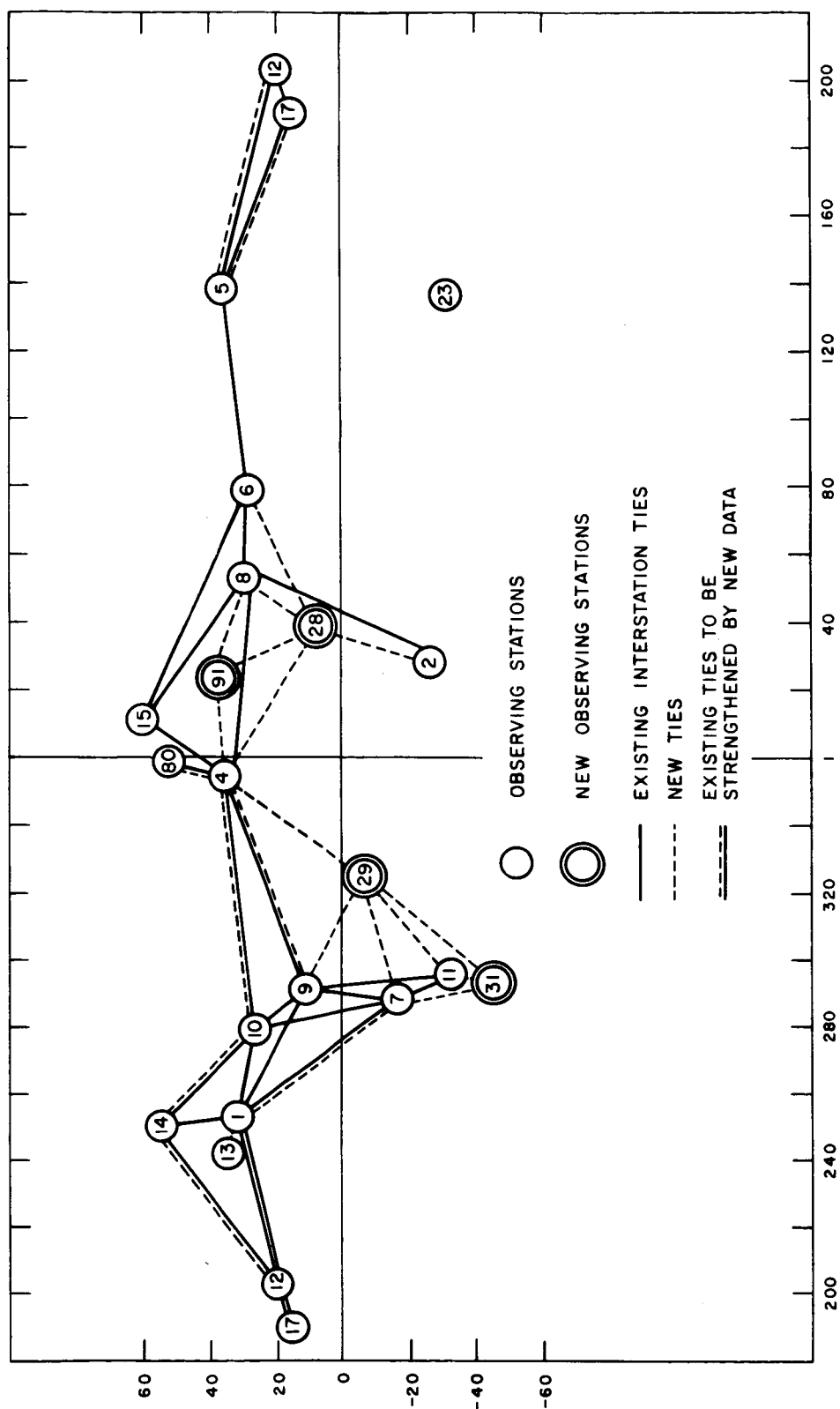


Figure 1. SAO geometrical network.